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NURSERY STOCK PESTS AND THEIR REPRESSION.

F. H. HALL.

Nursery stock is, undoubtedly, the chief disseminator of many of the orchardist's most dreaded and most harmful insect enemies. Several of these pests are wingless, frequently they are legless or so small that crawling far is impossible, and yet too large to be carried by the wind; so that some power outside themselves is necessary for their spreading to other plants than those upon which they are born. Probably a few of these lice or scales attach themselves to the legs of birds or larger insects, fall upon the hands or clothes of passing persons or are carried on the fruit; but their dissemination to any distance must be chiefly through shipment of nursery stock to which the insects or their eggs are attached.

Most of these insects are small, and inconspicuous unless in large numbers, so that, without special care or an expert's knowledge, they easily escape detection upon the young trees; and Nature has made up for their minuteness, as she often does, by endowing them with extraordinary reproductive powers. Once established, they quickly increase in number and destructive power and become a serious menace to tree and orchard.

*This is a brief review of Bulletin No. 136 of this Station on Inspection of Nurseries and Treatment of Infested Nursery Stock, by V. H. Lowe. Anyone specially interested in the detailed account of the investigations or descriptions of the insects will be furnished, on application, with a copy of the complete Bulletin.*
This danger is recognized by all entomologists and most fruit-growers; and in many states those interested in the question have united in demands, which have been granted by the legislatures, for laws compelling the inspection of nursery stock sold in these states. New York, as yet, has no such law, but to meet the requirements of other states it is necessary that nurseries from which stock is to be exported be inspected and pronounced free from seriously injurious insects and plant diseases. This Station has endeavored, so far as was possible with the limited force of entomologists and other demands upon their time, to assist the nurserymen by making the examinations.

Many nurseries and green houses were inspected, mostly in Ontario County, and nearly all the species of trees, shrubs, vines and plants commonly grown for sale examined. The inspections have been made with thoroughness. The surroundings of the nurseries were noted, old orchards or shrubbery adjacent and neglected fence corners examined with care, blocks of stock crossed and recrossed, at different times during the season if possible, and all suspicious looking trees closely scrutinized. The different insects have different hiding places and modes of concealment; the scales are usually dull colored, they may seem to the untrained eye only roughened places on the bark and they may be hidden under raised flakes of old bark, in scars where branches have been removed or in angles between buds and branches; the woolly louse of the apple secretes a downy covering somewhat like mold on the under sides of the branches, beneath which it may live unsuspected; or it may dwell in galls upon the roots of the infested tree; the case-bearers form minute homes for themselves like pimples or little tubes upon the young sprouts and branches; and the borers secrete themselves in channels and caves in the wood at or below the surface of the ground. All these hiding places and tricks of concealment must be borne in mind and detected by the sharp eyes or magnifying glass of the examiner. If any tree is infested with injurious insects liable to be transported with the stock or is affected with disease it should be destroyed or so treated that no danger of spreading insects or diseases shall exist.
Benefit of inspection. By this careful inspection, the danger of sending out unsafe stock at that time and from that nursery is avoided, and the nurseryman visited becomes more careful and is made more familiar with the pests liable to be found upon his stock; other nurserymen also, who are brought into competition with this certified stock, are obliged to take similar measures or fall to the rear in the struggle for trade. It is not possible, of course, in any inspection which does not include examination of every tree, to prevent completely the sending out of infested stock, but if, in connection with such official or semi-official examination, the orchardist becomes his own inspector and notes carefully the appearance of his growing orchards and of trees and shrubs received, the spread of such dangerous pests as the San José scale can be almost wholly prevented.

Results of Station inspection. Most of the nurseries examined by the Station Entomologist were found practically free from insect pests of a serious nature, but ten important species were found at different times in sufficient numbers to cause serious injury. In such cases efforts were at once made to clean out the stock thus infested, the nurserymen cheerfully taking the steps thought advisable by the inspector. The trees most commonly found infested were the apple, very commonly of the Ben Davis and Yellow Transparent varieties, and the standard pears, with woolly louse of the apple; and the peach, with borers. The insects found may be classified as: Scale insects—oyster shell bark louse, scurvy bark louse, New York plum Lecanium, the oak scale and the San José scale; plant lice—woolly louse of the apple; borers—peach-tree borer; case-bearers—pistol-case-bearer and cigar-case-bearer; and the bud moth.

Scale insects are among the most common of insect pests, dreaded not only because of the damage they do but because of the difficulty of eradicating them when once they are firmly established in orchard or nursery. The best time for treatment, in fact the only time when success is probable, is when they first appear and affect only a few trees. From these the scales can be eradicated by thorough measures or the trees be burned without great loss, but the scales are so inconspicuous that
they are very liable to be unnoticed until they have become widespread. All species of scale insects are alike in secreting or otherwise forming a protective shield under which they live, suck the plant juices, lay their eggs or give birth to young and die; and all are suctorial insects—that is, they do not eat the tissues or the plants but pierce the bark, the epidermis of the leaf or the skin of the fruit with their tube-like mouth parts. Poisons have no effect upon them but caustic washes, such as kerosene emulsion, kerosene-water mixture, tobacco decoction or whale-oil soap [See Bulletin No. 87] may be used with good success if applied when the young scales have left their mother shields and have not yet formed any of their own, or if the scales are loosened from the bark by gentle scraping or by the use of a stiff brush. If kerosene emulsion or whale oil soap are used in the fall or winter, when there is no danger of injuring the foliage, they may be applied at the rates of 1 part to 3 of water and of 1 pound to 2 gallons of water, respectively; but for spring treatment against the young scales, when vegetation is tender, 1 part of kerosene to 7 of water or 1 pound of soap to 7 gallons is as strong as it is expedient to use. Only the best whale-oil soap should be used, many inferior kinds being found on the market. The Station can recommend that manufactured by Leggett Bros., 301 Pearl St., New York or by James Good, 514-518 Hurst St., Philadelphia. Dr. J. B. Smith of the New Jersey Station recommends a home-made fish-oil soap composed of 3½ pounds of concentrated lye, 7½ gallons of boiling water and 1 gallon of fish oil. This mixture should be boiled two hours and the resulting soap used at a strength of 1 pound to 1 gallon of water.

Fumigation with hydrocyanic acid gas is a very effective remedy against insects of this character, but, because of the appliances needed and the amount of work involved, it has not been found expedient in most instances to use it for orchard treatment in the east. Where nursery stock is stored or handled in large quantities, it is probable that this will be found a most practical means of killing all insects upon the stock. The storage cellar or special fumigating house should be made perfectly tight, and treatment is best made at night or in cloudy weather to prevent injury to delicate stock. For a space of 150 cubic feet 1 ounce of fused potassium cyanide is required. A glass or glazed earthenware dish
is placed upon the floor and one ounce of sulphuric acid and 3 ounces of water poured into it. When everything else is ready the cyanide is added, the operator leaves as quickly as possible and the door is closed for the night. The room must be thoroughly ventilated before any one enters as the gas formed is one of the deadliest poisons.

Typical of scale insects and, at present most dreaded and most discussed of any of them, is the San José scale. This insect has excited great fear in the east, not entirely because of the damage it has already done here, but by reason of its destructive possibilities as shown by its work in the Pacific Slope orchards, its widespread distribution and the ease with which it may be still further disseminated by means of infested nursery stock. Its history in the United States dates back to 1870, when its work was known in the San José Valley, California, but it was first discovered in the east in 1893. It is now known to be in more than twenty states, the District of Columbia and Canada. In this state the chief centers of infection are on Long Island and along the Hudson River. It is essential that nurserymen and fruit-growers be on the lookout for it and be able to recognize it.

This scale is not particular in its choice of food plants, it having been found upon plants of nearly every species grown in eastern nurseries. The female scales are much more numerous than the males, as is the case with most scale insects. They are circular in outline, from 0.04 to 0.08 inch in diameter, nearly flat, and gray in color with a pale or reddish yellow, slightly raised spot near the center which is due to the shed skin of the young larva and is always plainly marked. The male scales are smaller than the females and are oblong oval in shape. Both sexes may be found upon the bark in the winter, varying from half grown to full size, sometimes clustered in great numbers, sometimes scattered, as shown in the different figures of Plate I. The insects mature in the spring and the young are born alive and not hatched from eggs as with most other scales. The young are probably born in May and early June in this latitude, remain under the mother scales for a short time and then come forth to find
places in which to insert their sharp, threadlike setæ, or mouth parts. When first born they are almost microscopic in size, oval in shape and reddish or dull yellow in color. By the time they have chosen their permanent locations threadlike secretions appear on the back of each little insect and these, with the cast skins of the successive moltings, form the protective shields. The mothers produce about 400 young, the period of maternity lasting for six or seven weeks, and then die, leaving the young scales to continue the species. The adult male is a delicate two-winged, orange colored insect.

Probably the most common scale in the orchard, **other scale insects** indeed so common that it has come to be considered almost a matter of course and of little importance, is the oyster-shell bark-louse. Not so destructive as many other scale insects, it may still do serious damage in young orchards, so care should be taken that it is not introduced on young stock. The protective shield is shaped much like a long, narrow oyster-shell, hence the name, and is ash gray in color. The female lay eggs which pass the winter under the scales, hatching in late May or in June, the mother herself growing smaller and smaller as the eggs are produced until little is left but a withered skin under one end of the scale. The young lice, unlike those of the San José scale probably never go to the leaves and are found only rarely on the fruit. Their appearance is shown in the upper figures of Plate II.

The scurfy bark-louse is nearly as common as the oyster-shell bark-louse, which it greatly resembles in life history and habits, but its scales are quite different in shape, being broadly oval, and are of a whitish color which makes them more conspicuous. They are shown at Fig. 4, plate II.

The New York plum Lecanium, so prevalent and so destructive in 1893 and 1894, has now largely disappeared owing to the attacks of parasitic and predaceous insects and to climatic changes; but favorable conditions may cause other outbreaks if care is not taken to exterminate the small colonies now existing. These scales are shown at Plate II, fig. 5, from which they are seen to be large, oval, fleshy scales, looking when magnified much like little turtles on a log. They pass the winter, not as eggs but as larvae, the egglaying being done in May and June
and the young larvæ settling for the summer mostly upon the leaves of the infested trees. They seem to prefer the under surfaces and collect along the midrib and larger veins. At this time they are very small and almost transparent so that a magnifying glass is frequently necessary for their detection. In August or September, unlike the preceding species of scales which remain fixed when once a location has been chosen, the young Lecaniums, now of a dark, reddish brown color, migrate to the twigs and branches in whose scars and crevices they sometimes cluster several deep for winter protection.

Another scale, shown at Plate II, fig. 6, is that of the oak. The female scale of this species is nearly circular in outline, somewhat conical in shape, dark or yellowish green in color and produces a pit or depression in the bark upon which she rests. The scale affects only the oak and has probably never done much damage except in isolated instances.

Plant lice. Plant lice of nearly all species were very prevalent during 1897 and will be discussed in detail in a subsequent bulletin. The species most commonly found in the nursery was the woolly louse of the apple, whose appearance and work are illustrated in Plate III. This plate shows the characteristic, woolly, mold-like covering secreted by the lice, something of their shape, numbers and appearance when the protective cover is removed from the branches, the manner in which they cluster during the winter in crevices and scars in the bark, and the galls formed by them on the roots. The lice upon nursery trees can be easily killed by touching these infested spots with a cloth soaked in kerosene oil.

Peach tree borer. The peach tree borer was the only insect of this character found doing serious injury in the nurseries of the State, and this was not so abundant as during 1896. The borers are the larvæ of wasp-like moths, of which the male and female are shown at Fig. 2, plate IV. The female moth lays her eggs upon the tree at the crown of the root and the larvæ, shown at Figs. 1 and 3, bore into the wood, weaken the trunk, cause deformation and allow entrance of disease and decay. Means which will prevent the moth from laying her eggs upon the trunk, such as surrounding the tree with wire or paper shields, mounding up the
earth or smearing the trunk with some offensive substance, are
most practical; for the only way of getting rid of the borers
themselves is by cutting them out or piercing them in their
tunnels with a sharp knife or pointed wire.

The pistol-case-bearers were described in full in
Case Bulletin No. 122 and mention was there made of
bearers. the only other species of case-bearer, the cigar-
case-bearer, which was found in the nursery in-
spception. These insects are quite similar in character and
habits, the adults being tiny, steel-gray moths and the case-
bearers little caterpillars, which construct for them-
selves small houses so shaped as to give them their names.
These little houses are attached, "on end," to the bark of the
young twigs in the fall, and in the spring the little caterpillars
move them to the opening buds and spreading leaves and under
this protection eat their way into the tender tissues. Spraying
with Paris green, London purple or green arsenite early in the
spring before the buds open, so that the first meal of the little
raiders shall be a poisoned one, is the only successful method
of treatment. Fumigation is probably the best means of destroy-
ing them on nursery stock, as the cases form quite an effective
protection against washes of all kinds.

The bud-moth is similar in habits to the case-
bearers, the adults being dark, ash-gray moths
marked with a cream white band across the front
wings, and the caterpillars passing the winter under little blankets
made of silk which are about one-eighth of an inch long, resem-
ble the bark in color and are so attached to it that they lie close
and are hard to detect. The little brown caterpillars, however,
unlike the case-bearers, leave their tiny retreats in the spring to
feed on the buds and later on the unfolding leaves. These they
draw together with silken threads to form "nests" in which they
pupate, each little caterpillar in its tube of dead leaf tissue.
Early spring poisoning and cutting out the nests of dead leaves
are the remedial measures most likely to give success.

Nursery experiments. Plant lice proved very troublesome in the nur-
series during 1897, attacking the tender foliage
at the tips of the branches and causing them to
curl so badly that they surrounded the lice and
made it impossible to reach them with a spray. As nursery trees are small and pliant it was thought that the tips of the branches could be bent over quite easily and dipped into soap solution. Experiment proved this method to be quick, practical and inexpensive. The solution, 1 pound of whale oil soap to 7 gallons of water, was carried in pails by the men, who bent over the tops of the trees and held the infested tips in the solution for about two minutes. The lice were all killed and the foliage was not injured.

Flea beetles on young apple grafts were successfully kept in check by three sprayings of green arsenite at a strength of 1 pound to 100 gallons of water, damage to foliage being prevented by making the mixture "milky" with lime. One application of this solution proved effective against canker worms on one block of these grafts.

A small block of cut leaved birch in a Geneva nursery was badly infested with thrips, small, almost microscopic, insects which fed on the soft parts of the leaves. They are winged and very quick at taking flight, so that it is difficult to reach them with insecticides. They were successfully combated, however, by spraying with whale oil soap solution [1-to-7], containing 1 ounce of flowers of sulphur to 1 gallon of the solution.

The Station would recommend to all nurserymen and fruit growers to consider the advantages of a nursery inspection law; but until that is obtained would urge upon each one the utmost personal care to send out and to receive for planting only stock which harbors no scale insects, no plant lice, no borers, no case-bearers and no bud-moths. Examine carefully all rough places upon the bark, all scars from removed branches, all crevices, and all close angles between trunks and branches. Notice closely the union of stock and scion of root grafts and the root crowns for traces of borers and see that there are no galls upon the roots. Use kerosene emulsion or whale oil soap solution freely if scales or plant lice are discovered and cover the opening buds and unfolding leaves with some arsenical poison if during the winter hibernating case bearers or bud-moths are found. By taking these precautions the danger of spreading the dreaded San José scale and similar insects will be reduced to a minimum.
EXPLANATION OF PLATES.

PLATE I.—The San José scale; Fig 1, infested pear [Duchess d' Angouleme;] 2, portion of the pear enlarged showing scales about four times natural size; 3, infested pear twig, natural size; 4, section of the same, enlarged.

PLATE II.—Fig. 1, the oyster-shell bark-louse, natural size; 2, view of under surface of some of the scales showing eggs, enlarged; 3, photomicrograph of some of the eggs; 4, scurfy bark-louse, natural size; 5, plum lecanium, a, enlarged, b, natural size; 6, the oak scale, natural size.

PLATE III.—The woolly louse of the apple. Fig. 1, infested apple twig, natural size; 2, section of the same twig enlarged showing gall and lice; 3, roots of young apple showing galls made by the lice; 4, some of the galls, natural size; 5, scar on trunk of young apple tree in which lice have congregated.

PLATE IV.—Fig. 1, plum root showing work of peach tree borer; 2, a, pupa case with chrysalis emerging; b and c, male and female moths; 3, larva, two views. [Fig. 2, natural size, Fig. 3 slightly enlarged. From photographs by Mr. F. A. Sirrine]. 4, pistol-case-bearers hibernating on apple twig, natural size; 5, plant lice, Hyalopterus pruni, on under surface of plum leaf, enlarged; 6, young apple leaves drawn together by larva of bud moth.